



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/501,114	02/10/2000	Yonhua Tzeng	A029 1080	3416

7590 12/24/2002

CHRISTOPHER B. LINDER
THOMAS, KAYDEN, HORSTEMEYER & RISLEY
100 GALLERIA PARKWAY
SUITE 1750
ATLANTA, GA 30339

EXAMINER

MARKHAM, WESLEY D

ART UNIT	PAPER NUMBER
----------	--------------

1762

DATE MAILED: 12/24/2002

16

Please find below and/or attached an Office communication concerning this application or proceeding.

Ms 16

Office Action Summary

Application No.

09/501,114

Applicant(s)

TZENG, YONHUA

Examiner

Wesley D Markham

Art Unit

1762

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 21 October 2002.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1,3 and 5-28 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1,3 and 5-28 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☒ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____
- 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____

DETAILED ACTION

Response to Amendment

1. Acknowledgment is made of applicant's amendment C, filed as paper #15 on 10/21/2002, in which Claims 1, 5, 8, 13, and 15 were amended, and Claims 19 – 28 were added. Claims 1, 3, and 5 – 28 are currently pending in U.S. Application Serial No. 09/501,114, and an Office Action on the merits follows.

Drawings

2. This application has been filed with informal drawings which are acceptable for examination purposes only. Formal drawings will be required when the application is allowed.

Claim Objections

3. The objections to Claims 13 and 15, set forth in paragraph 5 of the previous Office Action (i.e., the non-final Office Action, paper #11, mailed on 6/27/2002), are withdrawn in light of applicant's amendment C.

Claim Rejections - 35 USC § 112

4. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Art Unit: 1762

5. Claims 1, 3, 5 – 12, 19, and 26 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.
6. Regarding amended independent Claim 1 (from which Claims 3, 5 – 12, and 19 depend), the claim recites, in part, "...introducing, in the absence of a gas stream, a liquid precursor substantially free of water and methanol and at least one carbon and oxygen containing compound having a carbon to oxygen ratio greater than one into an inlet of the reaction chamber..." This language renders the claims vague and indefinite because, if the liquid precursor is substantially free of water and methanol and at least one carbon and oxygen containing compound having a carbon to oxygen ratio greater than one, it is unclear what material or materials the liquid precursor contains in order to promote diamond growth on the substrate as claimed by the applicant. In light of the applicant's specification and for the purposes of examination only, the examiner has interpreted the aforementioned claim language to be equivalent to "...introducing, in the absence of a gas stream, a liquid precursor substantially free of water and containing methanol and at least one carbon and oxygen containing compound having a carbon to oxygen ratio greater than one into an inlet of the reaction chamber..."
7. New Claim 26, which depends from Claim 25, recites the limitation "promoting diamond growth" in line 1 of the claim. There is insufficient antecedent basis for this limitation in the claim. For the purposes of examination only, the examiner has

interpreted the aforementioned limitation to be equivalent to “producing diamond crystals of diamond films”.

Claim Rejections - 35 USC § 103

8. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

9. The rejection of Claims 1, 3, and 5 – 18 under 35 U.S.C. 103(a) as being unpatentable over Miyanaga et al. (USPN 5,626,922) in view of Senateur et al. (WO 95/02711) and Pryor (USPN 5,236,545) (i.e., for Claims 1, 3, 5 – 7, and 9 – 18), and in further view of Glesener et al. (USPN 5,381,755) (i.e., for Claim 8), set forth in paragraphs 8 – 12 of the previous Office Action, is withdrawn in light of applicant’s amendment C. Specifically, independent Claim 1 (from which Claims 3 and 5 – 12 depend) and independent Claim 13 (from which Claims 14 – 18 depend), as amended, require plasma depositing the diamond on a substrate in the absence of a carrier gas. This limitation is not taught or reasonably suggested by the aforementioned combination of references.
10. Claims 1, 3, 5 – 7, and 9 – 28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Semiconductor Energy Lab (JP 05-097583 A), referred to

hereinafter as SEL, in view of Pryor (USPN 5,236,545) and either Versteeg et al. (USPN 5,451,260) or Robson et al. (USPN 5,874,014).

11. Regarding independent Claims 1, 20, and 21, SEL teaches a method for forming diamond crystals or a diamond film (Abstract), the method comprising disposing a substrate "4" in a reaction chamber (paragraph [0011] and Figure 3), introducing, in the absence of a gas stream, a precursor containing methanol or ethanol (i.e., a carbon and oxygen containing compound having a carbon to oxygen ratio greater than one) into an inlet of the reaction chamber (Figure 3, Abstract, and paragraphs [0010] – [0012]), vaporizing the liquid precursor (paragraph [0012]), and subjecting the vaporized precursor, in the absence of a carrier gas, to a plasma under conditions effective to excite the precursor and promote diamond growth on the substrate (paragraphs [0010] – [0020]). Further, the liquid precursor taught by SEL is 100% alcohol (paragraph [0010]), and none of the examples of diamond deposition taught by SEL include any water in the liquid precursor material (paragraphs [0013] – [0020]). As such, the liquid precursor of SEL is substantially free of water. In addition, although SEL uses the term "excited" as opposed to "disassociated" to refer to the vaporized precursor material (paragraph [0011]), a microwave-based plasma is formed (paragraph [0011]) and therefore the vaporized precursor material is inherently disassociated (i.e., because a plasma inherently contains disassociated material species). Further regarding independent Claim 20, SEL teaches a diamond deposition rate of 0.8 micrometers per hour (paragraphs [0014] and [0018]). The examiner has reasonably interpreted a deposition rate of

0.8 micrometers per hour to be “about 1 micrometer” per hour, thereby meeting the diamond deposition rate limitation of Claim 20. SEL does not explicitly teach that the liquid precursor contains methanol and at least one carbon and oxygen containing compound having a carbon to oxygen ratio greater than one. Specifically, SEL teaches liquid precursors such as methanol and ethanol (Abstract and paragraph [0011]) and that the diamond can be deposited “with 100% of alcohols” (paragraph [0010]), but does not explicitly teach using a combination of methanol and another compound having a carbon to oxygen ratio greater than one as the liquid precursor. Pryor teaches that, in the art of depositing diamond films by a microwave plasma CVD process (i.e., a process analogous to that of SEL), carbon-containing precursors such as methanol or ethanol can be utilized, as well as mixtures thereof (Col.9, lines 3 – 20). In other words, Pryor teaches the functional equivalence of individual methanol and ethanol precursors (e.g., as suggested by SEL) and combined methanol / ethanol precursors for depositing diamond in a plasma enhanced CVD process. Therefore, it would have been obvious to one of ordinary skill in the art to utilize a mixed methanol / ethanol liquid precursor mixture in the process of SEL with the reasonable expectation of success and obtaining similar results (i.e., successfully depositing a diamond film on a substrate by using liquid alcohol-based precursors without a carrier gas, specifically hydrogen, as desired by SEL) when compared to utilizing either methanol or ethanol precursors individually. In addition, SEL does not explicitly teach that the alcohol-based liquid precursor is a liquid when introduced into the inlet of the reaction chamber. Specifically, SEL

teaches that vapor of the liquid precursor is introduced into the reaction chamber (paragraphs [0011] and [0012]). Versteeg et al. teach a liquid delivery system and method for the CVD of films in a reaction chamber (Abstract). Versteeg et al. also teach that any liquid organic precursor solution can be used in their liquid delivery system (Col.2, lines 14 – 15) and that a wide variety of films can be deposited (Col.5, lines 50 – 56). The liquid delivery system can be utilized in a microwave plasma enhanced deposition processes (i.e., a process analogous to that of SEL) (Col.2, lines 66 – 68, and Col.3, lines 1 – 2). In this system, a mist of the liquid precursor is introduced into an inlet of the reaction chamber, after which the liquid precursor is vaporized and comes into contact with a substrate to deposit a film (Col.2, lines 3 – 13 and 44 – 68, and Col.3, lines 1 – 14). Versteeg et al. teach that this method of precursor delivery is extremely simple and economical, and it avoids the need for cumbersome mass flow controllers, carrier gases, and heated sources and lines (Col.5, lines 36 – 44). It would have been obvious to one of ordinary skill in the art to utilize the liquid delivery system and method of Versteeg et al. to introduce the alcohol-based liquid precursor of SEL (i.e., to introduce the precursor as a liquid into the inlet of the reaction chamber) with the reasonable expectation of (1) success, as the precursors of SEL are alcohols (i.e., organic liquids), and Versteeg et al. teach that any liquid organic precursor solution can be used in their liquid delivery system and that the system can be utilized in a microwave plasma enhanced deposition processes (i.e., such as the one of SEL), and (2) obtaining the benefits of using the aforementioned liquid delivery system, such as its simplicity,

Art Unit: 1762

economic nature, and avoidance of cumbersome mass flow controllers, carrier gases, and heated sources and lines. Robson et al. teach that, in the process of depositing diamond from precursors such as ethanol, methanol, and isopropanol, the precursors are generally gaseous or vaporize to a gaseous form upon introduction into the deposition chamber (Col.13, lines 15 – 26). Therefore, it would have been obvious to one of ordinary skill in the art to introduce the liquid precursors of SEL into an inlet of the reaction chamber of SEL and subsequently vaporize the precursors (i.e., as opposed to first vaporizing the precursors and then introducing the vapor, as suggested by SEL) with the reasonable expectation of (1) success, as Robson et al. teach that such a process was known in the art at the time of the applicant's invention, and (2) obtaining similar results (i.e., successfully depositing diamond from a liquid precursor, regardless of whether the liquid precursor is vaporized prior to introduction into an inlet of a deposition chamber or after introduction into the inlet). In addition and regarding independent Claim 20, if the applicant intends to exclude diamond deposition rates of 0.8 microns per hour by reciting a diamond growth rate of "between about 1 micrometer and 2.7 micrometers per hour", such a limitation would still be obvious over the combination of SEL, Prior, and Robson et al. Specifically, SEL suggests that the growth rate of diamond is linked to the deposition temperature (i.e., higher temperatures lead to higher growth rates) (paragraph [0018]). In addition, Robson et al. teach that higher plasma power densities can be used to increase the rate of diamond deposition (Col.11, lines 47 – 52) and teach a diamond deposition rate of 1.3 micrometers per

hour (i.e., a deposition rate within the applicant's claimed range) (Col.15, lines 42 – 44). In other words, the rate of diamond deposition is a result / effective variable that can be controlled by adjusting the substrate temperature and/or the plasma power density. Therefore, it would have been obvious to one of ordinary skill in the art to optimize the rate of diamond deposition as a result / effective variable dependant on, for example, substrate temperature and plasma power density, through routine experimentation depending on the desired diamond film thickness and end-product utility.

12. The combination of SEL, Pryor, and either Versteeg et al. or Robson et al. also teaches all the limitations of independent Claims 13 and 25 as set forth above in paragraph 11 and below. Specifically and regarding Claims 13 and 25, please note that SEL teaches that the CVD of diamond is "plasma enhanced" (Abstract and paragraph [0011]), the apparatus includes an inlet "2", a "disassociation zone" (i.e., the area in which the plasma of SEL is formed), a deposition zone (i.e., the zone in which the substrate is located), and an outlet "5" (Figure 3 and paragraph [0011]), and the vaporized precursor is flowed through the disassociation zone and through the outlet (Figure 3, Examples 1 – 3, and reference numbers "2" and "5"). The combination of SEL, Pryor, and either Versteeg et al. or Robson et al. does not explicitly teach that the plasma produced in the process (i.e., in the disassociation zone) contains OH, H, O, and carbon containing radicals. However, the aforementioned combination of references teaches all of the applicant's claimed method steps, including the mixed methanol precursor, the processing conditions

(i.e., temperature, pressure, microwave energy excitation), and the deposition of a diamond film from the plasma. Therefore, since the combination of references teaches the same precursors subjected to the same processing conditions to achieve the same end result (i.e., to deposit a diamond film) as that claimed and disclosed by the applicant, the process suggested by the prior art would have inherently produced the radical species claimed by the applicant.

13. The combination of SEL, Pryor, and either Versteeg et al. or Robson et al. also teaches all the limitations of Claims 3, 5 – 7, 9 – 12, 14 – 19, 22 – 24, and 26 – 28 as set forth above in paragraphs 11 and 12 and below, including a method wherein / further comprising:

- Claims 3 and 15 – The methanol is present in the liquid precursor in an amount between about 0.5 wt.% and about 99.5 wt.% of the liquid precursor. While this limitation is not explicitly taught by the combination of references above, the examiner notes that the applicant's claimed range of methanol weight percentages is broad enough to encompass essentially all methanol weight percentages in a mixed liquid precursor composition. Therefore, absent any showing of criticality or unexpected results, it would have been obvious to one of ordinary skill in the art to utilize a methanol weight percentage in the applicant's claimed range with the reasonable expectation of success and obtaining similar results (i.e., successfully utilizing a

mixed methanol precursor to deposit a diamond film, regardless of the methanol concentration).

- Claims 5, 16, and 17 – The methanol is supplemented with one or more carbon and oxygen containing compounds containing carbon, hydrogen, and oxygen with an atomic ratio of carbon to oxygen greater than one (Claim 16), preferably ethanol, isopropanol, acetone, or combinations thereof (Claims 5 and 17) (see paragraphs 11 and 12 above).
- Claims 6, 7, and 18 – The subjecting a vaporized precursor step is conducted at a pressure between about 1 mtorr and 250 torr, and the deposition zone / substrate temperature is between about 200 or 300° C and 1600° C (Abstract, Example 1, and Example 3 of SEL).
- Claim 9 – The substrate comprises a sheet or wafer of silicon, copper, aluminum, molybdenum, or alloys thereof (Examples 1 – 3 of SEL).
- Claims 10 – 12 and 14 – The plasma is formed by, or the disassociation step comprises, using electromagnetic energy, particularly microwave energy (i.e., an electrical discharge) to form the plasma (Abstract and paragraph [0011] of SEL).
- Claims 19, 23, and 27 – The carrier gas is hydrogen (Abstract and paragraphs [0010] and [0023] of SEL).

- Claims 22 and 26 – The diamond growth rate is between about 1 micrometer and 2.7 micrometers per hour (see paragraphs 11 – 12 above).
- Claims 24 and 28 – The liquid precursor consists essentially of methanol and at least one carbon and oxygen containing compound having a carbon to oxygen ratio greater than one. Specifically, the combination of SEL and Pryor reasonably suggests utilizing a 100% alcohol precursor mixture of only methanol and ethanol (i.e., a carbon and oxygen containing compound having a carbon to oxygen ratio greater than one) (see paragraphs 11 and 12 above).

14. Claims 20, 22, 23, 26, and 27 are rejected under 35 U.S.C. 103(a) as being unpatentable over Semiconductor Energy Lab (JP 05-097583 A), referred to hereinafter as SEL, in view of Pryor (USPN 5,236,545) and Versteeg et al. (USPN 5,451,260), and in further view of Robson et al. (USPN 5,874,014).
15. Please note that this rejection is made in the case in which the applicant intends to exclude diamond deposition rates of 0.8 microns per hour (as taught by SEL) by reciting a diamond growth rate of “between about 1 micrometer and 2.7 micrometers per hour”. The combination of SEL, Pryor, and Versteeg et al. teaches all the limitations of Claims 20, 22, 23, 26, and 27 as set forth above in paragraphs 11 – 13, except for a method wherein the diamond growth rate is between about 1 micrometer and 2.7 micrometers per hour. However, SEL suggests that the growth

rate of diamond is linked to the deposition temperature (i.e., higher temperatures lead to higher growth rates) (paragraph [0018]). In addition, Robson et al. teach that higher plasma power densities can be used to increase the rate of diamond deposition (Col.11, lines 47 – 52) and teach a diamond deposition rate of 1.3 micrometers per hour (i.e., a deposition rate within the applicant's claimed range) (Col.15, lines 42 – 44). In other words, the rate of diamond deposition is a result / effective variable that can be controlled by adjusting the substrate temperature and/or the plasma power density. Therefore, it would have been obvious to one of ordinary skill in the art to optimize the rate of diamond deposition as a result / effective variable dependant on, for example, substrate temperature and plasma power density, through routine experimentation depending on the desired diamond film thickness and end-product utility.

16. Claim 8 is rejected under 35 U.S.C. 103(a) as being unpatentable over Semiconductor Energy Lab (JP 05-097583 A), referred to hereinafter as SEL, in view of Pryor (USPN 5,236,545) and either Versteeg et al. (USPN 5,451,260) or Robson et al. (USPN 5,874,014), and in further view of Glesener et al. (USPN 5,381,755).
17. The combination of SEL, Pryor, and either Versteeg et al. or Robson et al. teaches all the limitations of Claim 8 as set forth above in paragraph 11, except for a method wherein the carbon containing compound (i.e., the precursor) includes a dopant element or moiety. However, Pryor does teach that diamond films are utilized in the

fabrication of semiconductor devices (Abstract). Glesener et al. teach that doped diamond for semiconductor devices can be produced by CVD utilizing carbon-containing source gases, and that natural diamond is not useful for such electronic devices because of the inability to control the dopant level (Col.1, lines 8 – 49, and Cols.3 – 4). It is known to incorporate the dopant into one of the precursors used to deposit the diamond film (Cols.3 – 4). Therefore, it would have been obvious to one of ordinary skill in the art to incorporate a dopant into the precursor of the aforementioned combination of references with the reasonable expectation of successfully controlling the dopant level of the diamond film (e.g., a level which is taught by Glesener et al. to be an important parameter for semiconductor / electronic devices such as those disclosed in Pryor) and producing diamond films for semiconductor devices as suggested by Pryor.

Response to Arguments

18. Applicant's arguments filed on 10/21/2002 have been fully considered but they are not persuasive. Specifically, the applicant's arguments are moot in view of the new grounds of rejection presented above.

Conclusion

19. The prior art made of record and not relied upon is considered pertinent to the applicant's disclosure. Tanabe et al. (USPN 5,624,719) teach that the process of depositing a diamond film in the absence of hydrogen has the advantage of being

Art Unit: 1762

able to utilize substrates that are liable to get brittle under the influence of hydrogen (Col.3, lines 24 – 26), and by suitably setting manufacturing conditions, diamond can be deposited in the form of grains or a film at a speed of more than 100 microns per hour (Col.4, lines 13 – 15).

20. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).
21. A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the date of this final action.
22. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Wesley D Markham whose telephone number is (703) 308-7557. The examiner can normally be reached on Monday - Friday, 8:00 AM to 4:30 PM.
23. If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Shrive Beck can be reached on (703) 308-2333. The fax phone

Art Unit: 1762

numbers for the organization where this application or proceeding is assigned are (703) 872-9310 for regular communications and (703) 872-9311 for After Final communications.

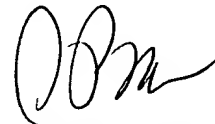
24. Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0661.



WDM

December 19, 2002

Wesley D Markham
Examiner
Art Unit 1762



SHRIVE P. BECK
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 1700